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Citation for final published version:

Petursdottir, Thorunn, Baker, Susan ORCID: <https://orcid.org/0000-0002-5616-4157> and Aradottir, Asa L. 2020. Functional silos and other governance challenges of rangeland management in Iceland. Environmental Science and Policy 105 , pp. 37-46. file

Publishers page: <http://dx.doi.org/10.1016/j.envsci.2019.12.006>
<<http://dx.doi.org/10.1016/j.envsci.2019.12.006>>

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FUNCTIONAL SILOS AND OTHER GOVERNANCE CHALLENGES OF RANGELAND MANAGEMENT IN ICELAND

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²⁶ Keywords

²⁷ Natural resource management, governance systems analysis, restoration, policy,

²⁸ commons

²⁹

³⁰

³¹ **Highlights**

³² □ Free roaming sheep during summer is forms the traditional rangeland grazing system in
³³ Iceland.

³⁴ □ Many of the grazed rangelands are in a degraded, even eroded, ecological condition

³⁵ □ The Public authorities public employees within the rangelands' SES have different
³⁶ perceptions on what constitutes as SLM.

³⁷ □ The vertical and horizontal dimensions of the rangelands' SES are not fully
³⁸ functionalintegrated.

³⁹ The Rangelands, as a SES of, are not surrounding the rangelands' utilization is not
⁴⁰ managed through with adaptive governance (AG).processes

²

¹ AG and co-adaptive management is needed to achieve sustainable rangeland utilization.

²

Abstract

⁷Every Social-ecological system (SES) promoting sustainable management of natural

⁸ resources in common ownership area is controlled steered in a complex governance system

⁹ that includes regulations through laws and policies, and, management d by the

¹⁰ administrative authorities operating across structure of the related multi-level institutional

¹¹ structures that, in turn, are governance system and shaped driven by stakeholder interests.

¹² In

12 addition, the long-term progress of natural resource management NRM not only thus
13 relies
14 on upon the existence of a well-structured and functional governance system, but needs
15 that
16 system to that adaptably facilitates sustainable resource management, in line with current
17 knowledge and best practices and in current knowledge.

18 In this research we mapped the administrative structure that of the governance system that
19 steers
20 the of the SES of rangeland management in Iceland and undertook a critical
21 analysis of the subjected the governance system's process to a critical analysis of its
22 structure
23 and, functions to and governance approaches to estimate examine if the respective
24 agricultural
25 and environmental policy targets had have facilitated system changes towards
26 improved sustainable rangeland management practices. A survey, based on a
27 questionnaire
28 distributed to selected public sector employees and sheep farmers, was used to gauge the
29 participants: a) attitude towards rangeland management practices, b) perception of the
30 level of
31 collaboration and state support for rangeland restoration and c) views on current
32 agricultural and
33 environmental policies on rangeland management.
34 The results strongly indicate that neither the current administrative structure nor the
35 governance
36 process itself have significantly facilitated the expected attitude changes within the
37 agricultural
38 sector or among local authorities. Furthermore, it has neither facilitated significant attitude
39 nor
40 behavioral changes among sheep farmers aimed at towards sustainable improved
41 rangeland
42 management, in line with current government agricultural and environmental policy
43 targets. Our
44 key findings support previous research that shows the governance system for rangeland
45 management in Iceland to be structurally limited and suffering from weak vertically and
46 horizontally integration partially integration dysfunctional. Furthermore, our
47 findings clearly reveal the need for improved governance for rangeland management and
48 the
49 requirement need for increased levels of knowledge application within the system.

36

37 **Introduction**

38 Sustainable land management (SLM) was defined by the UN 1992 Rio Earth Summit as:
39 "The
40 use of land resources, including soils, water, animals and plants, for the production of
41 goods to
42 meet changing human needs, while simultaneously ensuring the long-term productive
43 potential
44 of these resources and the maintenance of their environmental functions". In this paper,
45 we use

42 it to define sustainable rangeland management. Well-functioning rangelands provide
multiple
43 ecosystem services, such as water purification and storage, and biomass production (see
Havstad
et al., 2007). They also and have an important role in climate change mitigation due to their
2 capacity to sequester and store carbon in their biomass and soils (Lal, 2004; Cook et al.,
2013).
3 These ecosystems provide economic and social benefits for local communities that rely on
4 utilizing rangeland resources for human livelihood (Lund, 2007). However, substantive
parts of
5 the world's rangeland systems are degraded and often ecologically dysfunctional due to
6 unsustainable land use and poor resource management approaches (Marques et al., 2016).
7 Drawing upon Ostrom (2009), rangelands in communal or joint ownership are among one
8 of among the many combined human-nature systems that are viewed as social-ecological
systems
9 (SES). The SESs outcomes are the result of the interrelationship between the resource
systems,
10 the actors that utilize the resources through certain resource units, and the related
governance
11 system that controls and manages that utilization.

12 UtilizationAn SES surrounding the utilization of rangelands in communal or collective
13 ownership, when viewed as an SES, is an interconnected complex, one where the current
social-
14 ecological condition or changes within one of the SESs subsystems may affect changes
within
15 one of the SES subsystem or the system as a whole, by leveraging positive development or
16 halting back further progress (McGinnis & Ostrom, 2014). Furthermore, the socio-
economic
17 functions within the Furthermore, the outcome is SES of rangeland utilization are driven
by
18 complex environmental governance processes (see Berkes, 2006 & 2008). The level of
19 effectiveness and sustainability that a SES can achieve depends on how successfully these
20 processes are governed vertically and horizontally (Okpara et al. 2018; Torfing et al.,
2012),
21 avoiding the creation of institutional fragmentation and functional silos that might
otherwise
22 might reduce optimal organizational functionality of within the SES (Zelli, 2015; Serrat,
2017).
23 The governance processes need, for instance, to be adaptive to enable them to
continuously
24 facilitate best practices within the SES (Schultz et al., 2015), multilayered and cross-
scaled to
25 facilitate allow for experimentation and learning (Dietz et al., 2003; Folke et al., 2005;
Carlson
26 & Sandström, 2008), and collaborative to address and build social cohesion and resolve
potential
27 conflicts among all the stakeholders involved (Karpouzoglou et al., 2016; Paavola, 2007).
28 Furthermore, aA well-functioning rangeland governance process within a defined SES,
aiming

29 for sustainable resource utilization, needs to provide knowledge for iterative cycles of learning
30 based on reflexive examination of the outcomes of earlier decisions (Dale et al., 2013) and
31 continuously link new knowledge continuously to a comprehensive decision-making process.
32 That way, the risk of knowledge gaps between sectors or stakeholder groups involved in the
33 respective rangeland SES is minimized (Bouwen & Taillieu, 2004; Cundill & Fabricius, 2009).
34 If rangeland exploitation is not governed through consensus towards a long-term sustainability
35 of the SES in place, contrasting interests of various stakeholder groups may collide and even
36 drive resource over exploitation (Sayre et al., 2013; Brunson, 2012; Karl et al., 2012).
37 Various governance approaches for natural resource management, such as rangeland
38 management, are described in the literature (Lemos & Agrawal, 2006; Scarlett & McKinney
39 2016). An emerging one approach is adaptive governance, that based on references
40 (Berkes & Folke, 1998; Gunderson et al., 2015; Folke et al., 2005; Olsson et al., 2006), is and defined
41 by Hurlbert (2018) as a “...range of political, social, economic, and administrative systems that
42 develop, manage and distribute a resource in a manner that promotes resilience through
43 collaborative, flexible, and learning –based issue management across different scales” (p
44 25). Adaptive governance is recognized as an approach that includes all the key characteristics
1 needed for building a well-functioning rangeland governance process (Karpouzoglou et al.,
2 2016). In addition, a well-functioning rangeland governance process within a SES, This includes
3 the needs to provide knowledge for collaborative and iterative cycles of learning based on
4 reflexive examination of the outcomes of earlier decisions (Dale et al., 2013) and
5 continuously linking new knowledge to a comprehensive decision-making process. In this way,
6 Reflexive governance helps address the risk of knowledge gaps between sectors or stakeholder groups
7 involved in the respective rangeland SES is minimized (Bouwen & Taillieu, 2004; Cundill &
8 Fabricius, 2009). Furthermore, if rangeland exploitation is not governed through consensus,
9 towards a long-term sustainability of the SES in place, contrasting interests of various
10 stakeholder groups may collide and even drive resource overexploitation, particularly at a
11 place-based scale (Sayre et al., 2013; Brunson, 2012; Karl et al., 2012).
12
13 The SESs of rangeland utilization worldwide are complex and various land use practices,
14 other than livestock grazing, are often deeply interwoven in their utilization (Sayre et al., 2013).
15 In Iceland the main methods of utilization of rangelands is is one of the countries in the world

16 where rangeland utilization, mainly for through free roaming sheep grazing, which has
17 traditionally been is of high socio-cultural and economic social-ecological importance.
Thus,
18 although other types of utilization are growing in importance. Thus, the corresponding
SES is
19 relatively simple compared to other countries where rangeland management hasis more
often
20 embedded in multilayered SESs with has to address a variety of various utilization
practices.
21 Rangeland Hence, The SES surrounding rangeland utilization in Iceland provides an
22 opportunity to therefore well-suited to research that explores the existing governance
23 arrangements and processes, including related policy targets, and estimate to an
examination of
24 whether these if the structure and functions of its SES are supporting a robust SES in
rangelands.
25 the implementation of the current rangeland policy targets.
26 From around 1990 onwards, the Icelandic government has sought to enhanced the
sustainable
27 grazing management of the rangelands, introducing approved several new laws and,
followed by
28 regulations to help achieve, aimed at achieving achieved policy targets on improved
ecological
29 conditions. Various and enhanced sustainable grazing management of the rangelands.
Since
30 1990, Various rangeland management strategies, such as agri-environmental schemes and
31 programs, have been introduced in support of this policy approach (Crofts, 2011).
However,
32 Neither the governance processes nor neither the governance processes nor the outcomes
of
33 these interventions have been examined in an integrative systematic manner. The
34 lack of a comprehensive evaluation provides a unique opportunity to explore the
institutional
35 arrangements related to the SES of rangeland grazing management at a national level, and
to
36 analyze further what type of the sustainability consequences of the governance approaches
37 and resource management approaches that are being applied within the system.
38 In this paper we: i) map the administrative structure of for the governance system of the
SES of
39 rangeland management in Iceland; ii) subject the system to a critical analysis of its
structure,
40 functions and governance approaches; and iii) estimate if the respective agricultural and
41 environmental policy targets have facilitated sustainable rangeland management practices,
42 within this SES estimate how well the governance structure is perceived to operate
vertically and
43 horizontally
1 In particular, the paper explores: a) whether the actors in the governance system are
encouraging
2 sheep farmers are being encouraged to apply sustainable rangeland management practices,
in

3 line with existing policy targets, and by whom; b) the perception of the key administrative actors

4 within the governance system and of stakeholders (the sheep farmers) towards the current
5 management practices; and c) if the actors and stakeholders favour within the governance system

6 are favoring sustainable land management practices, as they are defined in Petursdottir, et al.

7 (2017) over and above other land management practices.

8

9 *Background*

10 Iceland is a parliamentary republic and a representative democracy. Although the country's

11 population counts amounts to only approximately roughly 350,000 inhabitants, Icelandic

12 governance arrangements are structured in a relatively hierarchical administrative structure,

13 comparable to the administrative structure found within other European countries. Due to the

14 nation's small size, the governance arrangement for natural resources uses involve relatively few

15 public agencies within each administrative level, and it has smaller stakeholder groups than

16 found in, compared to more populated countries.

17 Iceland is around 103,000 km², of which nearly 60% is categorized as highlands (>400 above

18 mean sea level). Approximately 40% of Iceland's the total land surface is state owned and over

19 85% of the highlands is categorized as commons (Óbyggðanefnd, 2019). Sheep farming for

20 lamb meat production is one of the main agricultural activities in Iceland. The lambs are born in

21 May and roam; roaming free with the ewe mothers on rangelands during summertime but
22 are gathered in late August or early September for fall slaughtering. Common grazing rights,

23 such as the right of most farmers to utilize local communal or collectively owned rangelands for

24 the free roaming sheep grazing during summertime, and traditions concerning collective sheep

25 gathering in the autumn thus form the social socio-economic backbone of the current sheep

26 farming system (Petursdottir et al., 2013; Ross et al., 2015). Although rangeland grazing is of

27 high socio-cultural, economic importance for sheep farmers (Stefánsson, 2018), research

28 shows that over 50% of the rangelands' ecosystems are severely degraded and may be
29 considered as ecologically dysfunctional units, not suitable for their current grazing regime

30 (Arnalds, 2015; Arnalds & Barkarson, 2003; Arnalds et al., 2001).

31 Apart from the domestic sheep grazing, close to 1000 domestic horses are grazed on several

32 commons in Northern Iceland during summertime (Halldórsdóttir, 2015). Other herbivores

33 utilizing the rangeland commons include migrating birds, such as geese and whooper
34 swans, and
35 around 5000 wild reindeer in reindeers in at the Eastern part of the country (Náttúrustofa
36 Austurlands, 2019).
37 Rules concerning grazing management of communal areas in Iceland were already
38 documented
39 in Grágás, a book of law from the Commonwealth period (930-1262 AD) (Karlsson et al.,
40 1992).
41 Nevertheless, unsustainable land uses, such as domestic livestock grazing and clear cutting
42 of
43 woodlands in earlier centuries, combined with harsh climate and fragile volcanic soil, led
44 to
45 severe soil and vegetation erosion and in many cases to ecosystem collapse (Arnalds et al.,
46 2001). Soil conservation became an official governmental policy goal in the beginning of
47 the
48 20th century, when recognition of rangeland degradation led to the first Icelandic *Act on*
49 *forestation, soil reclamation and defences against desertification* (1907); and the first
50 organized
51 actions to combat land degradation was launched in the same year (Crofts, 2011). This
52 was later
53 followed up by the establishment of the Soil Conservation Service of Iceland (SCSI)
54 (Crofts,
55 2011; Aradóttir Petursdóttir et al., 2013). The Act was revised in 1914, 1941 and 1965.
56 (Aradóttir et al., 2013).
57 The Act was the first Icelandic Act stating the importance of preventing soil erosion and
58 promoting improved land use (Aradóttir et al., 2013). The Act was revised in 1914, 1941
59 and in
60 1965 (Aradóttir et al., 2013). Sustainable rangeland management and ecosystem restoration,
61 in
62 addition to soil erosion, gradually started to gain further policy attention in the early 1960s,
63 (Aradóttir et al., 2013) but only attained a legal status in December 2018 when the Icelandic
64 parliament finally approved a new environmental *Act on Land Reclamation* (155/2018).
65 This
66 followed after several attempts over more than two decades to push for its revision over
67 more
68 than two decades (Crofts, 2011).
69 Although the concept of sustainable rangeland use started to gain attention in the
70 early 1960s, it was not listed officially listed as a task in an agricultural policy until after
71 1990
72 (Table 1) and was first defined within an agricultural regulation in 2003. The concept has
73 not yet
74 been defined within any environmental legislation but according to the new *Act on Land*
75 *Reclamation* (155/2018), the Mminister of Environment and Natural Resources has the
76 authority to follow the Act up and set a new regulation with a new definition
77 of offor what can be considered as sustainable (range)land use/management in Iceland.
78
79 but since then, the Icelandic government has approved several agricultural laws and
80 regulations
81 to direct rangeland governance toward sustainable rangeland management. Parallel, the

22 government supported various programs and projects aimed at increasing local and
national
23 awareness on the multiple values of soil conservation and land reclamation, as well as to
24 facilitate sustainable management of rangelands (e.g. Arnalds, 2005; Crofts, 2011;
Aradottir et
25 al., 2013; Petursdottir et al., 2013). These practices have focused particularly on building
up
26 cross-sectorial agri-environmental actions intended to strengthen the cooperation between
all
27 stakeholders involved in rangeland utilization, to improve rangeland management, and to
restore
28 degraded rangelands (Crofts, 2011). The main land improvement programs and projects
29 established or facilitated in the last decades were, in chronological order: i) Farmers Heal
the
30 Land program, ii) Local reclamation NGOs, iii) Quality Management in Sheep Farming
and iv)
31 Land Improvement Fund.
32 i) Farmers Heal the Land program (FHL):
33 The FHL program was established by the SCSi in 1990 with the aim of increasing
stakeholders'
34 involvement in rangeland management. The initial objectives of the FHL program were to
35 encourage restoration of degraded lowland rangelands and enhance trust and ease
cooperation
36 between sheep farmers and relevant authorities, and also to facilitate behavioral changes
towards
37 sustainable rangeland management (Arnalds, 1999; 2000). FHL is a governmental cost-
shared
38 voluntary program that is operated nationwide by the SCSi, in close collaboration with its
39 participants (mostly sheep farmers). The program mainly supports restoration activities
40 performed on privately owned lowland rangelands (Petursdottir et al., 2017). Currently,
roughly
41 550 farmers around the country participate in the FHL program (Einarsson, 2018).
42 ii) Local reclamation NGOs:
43 The *Act on Land Reclamation* approved in 1965 permitted the establishment of local
district
44 reclamation NGOs, although the first NGOs were not established until 1992. Since then,
14
7
1 other local restoration NGOs have been established around Iceland, but according to the
SCSi,
2 currently only 12 are active. The main aims of these NGOs are to: a) restore degraded
communal
3 rangelands and b) strengthen environmental awareness and increase land literacy within the
local
4 communities (Petursdottir et al., 2013). All the NGOs work on a voluntary basis, but work
in
5 close cooperation with the SCSi. They receive grants from the SCSi and specific
restoration
6 funds to buy fertilizer and seed for their projects (Crofts, 2011).
789

Table 1. Icelandic agricultural laws, regulations and agreements that mention sustainable rangeland management.

10 Phrases or terms that refer to sustainable land use or grazing management are set in bold type (translations by Th.P.)

Year/no Title/description Phrase or a term referring to sustainable land use or grazing management

1993/99 Agricultural Product Act If there is a risk that the activity goes against **preferable land use benchmarks**.

1995/124 Agricultural Product Act Sheep farming/grazing must be in line with **environmental protection**.

1998/70 Farming Act Land improvement should promote **sustainable land use** practices and take into

account international commitments regarding conservation of biodiversity.

2000/88 Agricultural Product Act Quality Managed Sheep (QMS) production is verification for lamb meat, produced in

accordance to with standards on defined production process, health and **environmental protection, land qualities and preferable land use benchmarks**.

2002/101 Agricultural Product Act Land use must be sustainable so that the **production capacity of the land is adequate and land utilization limited to keeping the vegetation cover in equilibrium or improving**, in the opinion of the SCSL.

2003/173 Regulation for Quality

Management in Sheep

Farming (QMS)

Definition for sustainable land use: maintaining **adequate biomass productivity and land utilization within the limits of keeping the vegetation cover in equilibrium or? or in improvement**, in the opinion of the SCSL.

2007/58 Agricultural Product Act Sheep farming is practiced in accordance to with **environmental protection, land**

qualities and sustainable land use practices. Quality Managed sheep production is verification for lamb meat, produced in accordance to with certificated standards concerning animal welfare, **sustainable land use practices** and healthy products.

2007 Agreement between the

State and farmers, of the

working condition in

sheep farming

Sheep farming is practiced in accordance to with **environmental protection, land qualities and sustainable land use practices**.

2013/1160 Regulation for Quality

Management in Sheep

Farming (QMS)

Definition for sustainable land use: **The use of land resources, including soils, water, animals and plants that do not deplete terrestrial natural resources, while simultaneously ensuring the long-term productive potential of the ecosystems and the maintenance of their functions**.

2016 Agreement between the

State and farmers, of the

working condition in

sheep farming

To promote the production of lamb meat certified by the QMS verification system, including all involved factors such as animal welfare, healthiness of products and **sustainable land use practices.**

2017/1166 Regulation for Quality

Management in Sheep

Farming (QMS)

Definition for sustainable land use: **The use of land resources, including soils, water, animals and plants that do not deplete terrestrial natural resources, while simultaneously ensuring the long-term productive potential of the ecosystems and the maintenance of their functions.**

11

12 Since 1990, the Icelandic government has approved several agricultural laws and regulations,

13 aiming to direct aimed at rangeland governance toward sustainable rangeland management. In

14 Parallel, the government supported new programs and projects aimed at increasing local
8

1 and national awareness on the multiple values of soil conservation and land reclamation, as well

2 as to facilitate the sustainable management of rangelands (e.g. Arnalds, 2005; Crofts, 2011; 3 Aradottir et al., 2013; Petursdottir et al., 2013).

4 The “Farmers Heal the Land” (FHL),, a governmental cost-shared voluntary program, 5 established by the Soil Conservation Service SCSi in 1990, was for instance the first 6 governmental program with a clear aim of increasing stakeholder (mostly sheep farmers’) 7 involvement in rangeland management. The initial objectives of the FHL program were to 8 encourage restoration of degraded lowland rangelands, to enhance trust and ease cooperation

9 between sheep farmers and relevant authorities, and to facilitate behavioral changes towards

10 sustainable rangeland management (Arnalds, 1999; 2000). The program mainly supports 11 restoration activities performed on privately owned lowland rangelands (Petursdottir et al., 12 2017). Currently, roughly 550 farmers around the country participate in the FHL program 13 (Einarsson, 2018).

14 The main land improvement programs and projects established or facilitated in the last decades

15 were, in chronological order: i) Farmers Heal the Land program, ii) Local reclamation NGOs,

16 iii) Quality Management in Sheep Farming and iv) Land Improvement Fund.

17 i) Farmers Heal the Land program (FHL):

18 The FHL program was established by the SCSi in 1990 with the aim of increasing stakeholders’

19 involvement in rangeland management. The initial objectives of the FHL program were to 20 encourage restoration of degraded lowland rangelands and enhance trust and ease cooperation

21 between sheep farmers and relevant authorities, and also to facilitate behavioral changes towards

22 sustainable rangeland management (Arnalds, 1999; 2000). FHL is a governmental cost-shared

23 voluntary program that is operated nationwide by the SCSi, in close collaboration with its 24 participants (mostly sheep farmers). The program mainly supports restoration activities

25 performed on privately owned lowland rangelands (Petursdottir et al., 2017). Currently,
 roughly
 26 550 farmers around the country participate in the FHL program (Einarsson, 2018).
 27 ii) Local reclamation NGOs:
 28 The *Act on Land Reclamation* approved in 1965 permitted the establishment of local
 district
 29 reclamation NGOs, although the first NGOs were not established until 1992. Since then,
 14
 30 other local restoration NGOs have been established around Iceland, but according to the
 SCSI,
 31 currently only 12 are active. The main aims of these NGOs are to: a) restore degraded
 communal
 32 rangelands and b) strengthen environmental awareness and increase land literacy within
 the local
 33 communities (Petursdottir et al., 2013). All the NGOs work on a voluntary basis, but work
 in
 34 close cooperation with the SCSI. They receive grants from the SCSI and specific
 restoration
 35 funds to buy fertilizer and seed for their projects (Crofts, 2011).
 36 Late in the 1990s, the Icelandic government took another large step towards
 acknowledging the
 37 need for improved rangeland management by adding the issue as a compulsory pillar to
 the
 38 Quality Management in Sheep Farming (QMS).) Scheme. iii) Quality Management in
 Sheep
 39 Farming (QMS):
 40 The QMS is a cross-compliance scheme that was formally introduced by the Ministry for
 41 Industry and Innovation in the Agricultural Commodities Agreement in 2000 and came
 into
 42 force in 2003 with the approval of the Legislation for Quality Management in Sheep
 Farming
 43 (QMS) (Table 1) (Arnalds & Barkarson, 2003). One of the aims of the QMS's aims is to
 secure
 9
 1 sustainable rangeland grazing management. Participation in the scheme is voluntary but
 sheep
 2 farmers that apply and successfully fulfill the QMS requirements of good farming practices
 3 and sustainable land use receive close to 30% higher subsidy payments from the State for
 their
 4 production than non-participating farmers (Karlsson et al., 2015; Þorlákssdóttir, 2015).
 Currently,
 5 approximately 1,750 sheep farmers (Ásbjörnsson, 2015), producing more than 90% of the
 6 annual lamb meat production (Karlsson et al., 2015), participate in the QMS.
 7 The Icelandic Food and Veterinary Authority control the QMS approval process, but the
 SCSI is
 8 responsible for: a) estimating the ecological condition of the rangelands utilized by QMS
 9 applicants/participants and b) verifying if the grazing areas under inspection fulfill the
 criteria
 10 for sustainable land use, as defined in the scheme's regulation. If the observed grazing
 areas do

11 not fulfill the minimum ecological requirements, the respective applicants/participants
 must
 12 provide and follow a ten-year restoration plan with measureable targets to qualify for
 subsequent
 13 participation in the scheme. Once such restoration plans are validated by the QMS system,
 the
 14 grazing of the respective areas is deemed sustainable and the farmers relying on grazing
 15 them for their meat production receive full QMS subsidy payments (Regulation for
 Quality
 16 Management in Sheep Farming, (QMS), 2013/1160). According to Arnalds et al. (2000)
 there
 17 are 72 rangeland commons or collectively owned rangelands in Iceland but it is not clear
 18 how many of these areas are utilized for sheep grazing within the QMS. Nevertheless, 26
 19 rangeland commons or collectively owned rangelands do not meet the minimum
 ecological
 20 condition requirements of the QMS and need to work in accordance to a ten-year
 restoration
 21 plan (Ásbjörnsson, 2015).
 22 In 2003, the government established the Land Improvement Fund (LIF) as a follow-up
 project to
 23 the QMS scheme, mainly to support farmers who, according to the scheme, need to restore
 some
 24 of their grazing areas to receive the annual QMS subsidy payments iv) Land Improvement
 Fund
 25 (LIF):
 26 The LIF was established in 2003, mainly as a follow-up project to support farmers who,
 27 according to the QMS scheme, need to implement restoration to receive the annual QMS
 subsidy
 28 payments. The fund is financed by the state central government and managed by the SCSI,
 but
 29 the Sheep Farmers Associations also give an annual financial
 30 contribution to the Fund. The main goals of the LIF are to: a) halt soil and vegetation
 erosion
 31 and prevent further land degradation, b) restore degraded ecosystems, in accordance with
 32 potential vegetation conditions and land use requirements, c) facilitate sustainable land use
 and
 33 d) mitigate climate change impacts through increased carbon sequestration in soil and
 vegetation
 34 (Eiríksson et al., 2018). Supported projects entitled to support must meet these goals
 35 and applicants that submit a comprehensive restoration/land use plan have priority for
 funding.
 36 Since its establishment, the LIF has emphasized focused on supporting compulsory QMS
 37 restoration projects, which now comprise over 50% of all allocated grants in 2017
 (Eiríksson et
 38 al., 2018).
 39

40 **Data collection and analysis**

41 To understand better the rangeland governance system, we mapped the
 42 system's formal administrative structure with through the use of secondary data sources
 and

43 information from respective appropriate webpages. We then used the results from a pilot study

10

1 investigating rangeland management in Iceland from a social-ecological system's perspective

2 (Petursdottir et al., 2013) to structure questions for an online survey. The online survey was
3 administrated in the winter 2011-2012, and circulated to public employees identified as
having an

4 administrative role in rangeland management (Table 2). In total, of 503 people received a
link to

5 the questionnaire, each receiving. Each of them received an email with a personal e-link
and

6 password. to the questionnaire. Two weeks later, a short reminder was circulated by email
to those

7 that had not yet replied, and again after a lapse of three weeks and of four weeks.

Participants from

8 the Agricultural University had shorter time to reply and only received two reminders, as its
9 postmaster inadvertently blocked the survey email for two weeks until this error was
discovered.

10 **Table 2.** Hierarchical and structural locations of people within the agri-environmental
governance system, identified

11 by the authors of this paper to have a role in rangeland management. Those that regularly
are in "face to face"

12 contact with farmers in their work are considered to have direct interactions with them,
those that irregularly or even

13 never meet with the farmers are considered to have indirect interactions with them.

Position Role Interactions with

farmers

Institute/ institution/ organization

Parliamentarians Elected members of the Icelandic
parliament. National policies and laws

N/A National Assembly

Ministry experts Administration and communication to all
related stakeholder groups and institutes.

Preparing laws and regulations for
approval and implementation

Indirect Ministry for Environment
and Natural Resources and

Ministry for Industry and
Innovation (incl. agriculture)

Aldermen (regionals) Elected member of regional authorities.

Local administration and decision making,
regional policy design and implementation

Indirect Regions, defined by the
state to highly depend on

sheep farming

University lecturers/professors Research and consultancy in her/his field
of expertise and providing education in
agricultural and/or environmental science

to students

Indirect/direct Agricultural University

Agricultural advisors Advising farmers on livestock breeding,

livestock husbandry, agronomy and

farm accounting

Direct Farmers Association

Icelandic Agricultural

Advisory Centre

Agricultural experts/managers Administration and interest monitoring for

the agricultural sector

Indirect/direct Farmers' Association

Icelandic Agricultural

Advisory Centre

Environmental advisors Advising farmers on rangeland grazing

and ecosystem restoration, supervisory

of land condition

Direct Soil Conservation Service

Environmental experts/managers Administration, monitoring of land

condition, control of land management,

diverse research focusing on terrestrial

ecosystems

Indirect Soil Conservation Service,

Forest Service, Institute of

Natural History, National

parks

Afforestation advisors/park rangers Advising farmers/land owners on forestry,

planning and monitoring afforestation

projects/ controlling of protected areas

Direct/indirect Forest Service, National

parks

14 We also sent the survey to sheep farmers to enable comparison of answers with those from the

15 various positions listed in Table 2. In parallel to the online survey, a hard

16 copy with a pre-paid return envelope was posted to 1261 sheep farmsteads. According to the

17 Icelandic Agricultural Statistic (2010) this represented 87% of all registered sheep farms in

18 Iceland at that the time. The sampling method is described in further detail by Petursdottir et al.

11

1 (2017). Both parts of the survey were posed with permission from the Icelandic data protection

2 authorities.

3 The survey questions were divided in three categories: Category 1 measured the attitude of

4 participants in the survey towards rangeland management; Category 2 measured their perception

5 on of the level of collaboration and state support for rangeland restoration; and Category 3

6 asked about their views on current agricultural and environmental policies on rangeland

7 management and on whom should be involved in designing and implementing policy targets

8 concerning rangeland management and restoration.

9 Each category consisted of two to four main questions, followed by two to six sub-questions; 30

10 questions in total. The participants were asked to express how much they agreed or disagreed

11 with given statements, using a five-step Likert scale (Neuman, 2006).

12 A Wilcoxon-Mann-Whitney, non-parametric test (Townend, 2009), was used to compare all

13 replies divided by sectors. Furthermore, in the cases where the Mann-Whitney test showed a

14 significant difference in response between the environmental and the agricultural sectors, the test

15 was run again based on the profession of the participants (Table 2). A Friedman test was used to

16 assess whether the ranking of the replies across all sectors were identical. The test was

17 performed independently for the replies from each sector.

18 **Results**

19 *Mapping the governance system's structure*

20 Legislation concerning rangeland management is prepared by the Ministry of Industries and

21 Innovation (MII), the Ministry for the Environment and Natural Resources (MENR) and related

22 governmental institutes, in collaboration with all main stakeholder groups (Fig.1). All new law

23 must be approved by the majority of the parliamentarians at Althing but the respective minister

24 prepares new legislations and is granted power to make more detailed provisions of approved law

25 by setting regulations. Currently, only the MENR runs an administrative office dealing with

26 sustainable land management, including restoration and reforestation, whereas the MII has neither

27 an official internal employee office nor a scientific or an administrative institute agency under its

28 auspice that addressing addresses rangeland management. Professional advice and small scale

29 financial support to sheep farmers concerning rangeland management and restoration (including

30 reforestation) are only provided by the extension service of the SCSi and the IFS (Icelandic Forest

31 Service), both institutes agencies under the auspice of the MENR (Table 2). Thus, the MENR

32 holds the scientific and the professional knowledge for designing and following-up environmental

33 policies and regulations related to rangeland management, while the MII holds the official decision-making capacity and the authority to set agricultural policies and regulations

34 concerning

35 rangeland management through the agricultural subsidy system, including the QMS payments.

36 The state government, the above mentioned ministries and related governmental institutes, such

37 as the Soil Conservation Service (SCSI), are key public institutions involved in policy setting and

38 follow-up processes concerning rangeland management. Other main organizations contributing to

39 the design and implementation of agri-environmental policies concerning rangeland management

40 are the Farmers' Association, local authorities and environmental NGOs (Fig. 1).

12

1

2 Figure 1. The political-administrative structure of the Icelandic governance system related to governing rangelands in

3 Iceland. management.

4 Organizations and institutions that play an active role in the process of designing and implementing agri-

5 environmental policies for rangeland management are denoted in by beige shapes; , but agencies that are less actively

6 involved in the process are denoted in by gray. (NPs1= National Parks; IINH2= Icelandic Institute of Natural History;

7 IFS3= Icelandic Forest Service; SCSI4= Soil Conservation Service of Iceland; AUI5= Agricultural University of

8 Iceland; FA6= Farmers Associations; IAAC7= Icelandic Agricultural Advisory Centre).

9 In line with the prevailing law and regulations, the organizations and institutions that play an active

10 role in the process of designing and implementing agri-environmental policies for rangeland

11 management are shown in beige in Figure 1 but the agencies that are less actively involved in the

12 process are gray (Fig. 1). The dashed line from the Ministry of Industry and Innovation to the

13 Farmers' Association symbolizes an indirect administrative connection, as the FA is a private

14 business interest organization, only partially funded by the state. The dotted line from the 15 Agricultural University to the Soil Conservation Service, to the Farmers' Associations and to the

16 sheep farmers symbolizes the indirect lines of influence between these agencies as they fall under

17 or are linked to the political auspices of different ministers (Fig. 1).

18 There is no cross-sectoral team of policy experts focusing on all social-ecological aspects related

19 to rangeland management in place within the governance system. Furthermore, no formal agri-

20 environmental transdisciplinary platform for knowledge application and decision-making exists

21 (Fig. 1).

13

1 The SCSI plays a key administrative role in implementing rangeland management policies. B but

2 the Farmers Association (FA) also has a role in the implementation phase, both as a

3 business interest organization, advocating for the business interests of their sectoral member
4 organizations, and through the Icelandic Agricultural Advisory Centre (IAAC), a
5 private corporation owned by the FA (Fig. 1) that runs a nationwide network of agricultural
6 extension offices. The FA is run and financed by the farmers themselves but also receives
7 annual
8 fixed payments from the State in accordance with agricultural agreements from 2015, with
9 part of
10 that amount allocated to the advisory system of the IAAC.
11 The Agricultural University of Iceland (AUI) is responsible for the education of the
12 majority of
13 acting sheep farmers and many of the employees of FA, IAAC and the SCSi. The AUI is
14 only
15 loosely linked to the policy process concerning rangeland management as it falls under the
16 auspice of the MESc (Ministry of Education, Science and Culture) but is without any
17 formal
18 land use policy-making connections to the MII (Fig. 1).
19 According to the *Act on Rangelands* no.6/1986, decisions on rangeland grazing
20 management
21 practices are in the hands of local authorities. Thus, local authorities are also directly
22 embedded
23 in the governance process as most of the rangelands are in public or mixed ownership,
24 under
25 local custody or collectively owned by two or more landowners. Environmental NGOs
26 and other
27 stakeholder groups, including the general public, participate indirectly in the governance
28 process
29 by, for instance advocating for improved rangeland management and commenting on
30 governmental plans concerning land use.
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35 Table 3. Answering rate to the survey from different institutions and organizations, divided by sectors.

Name / Sector Type Level Role Sent

surveys

Received

replies

Reply

rate

(%)

National assembly /

Officials

Parliament National National

policies/laws/

democracy/

cooperation

63 9 14

Ministry for environment and

natural resources (MENR) /

Officials

Governmental

department

National

Administration/

legislations

environmental

policies/ international

21 6 29

14

cooperation

Ministry for industries and

innovation (MII) / **Officials**

Governmental

department

National Administration/

legislations

agricultural policies/

international

cooperation

17 4 24

Municipalities/

Local authorities*

District

government

Regional Administration/

regional policies

131 57 44

The Agricultural University of

Iceland (AUI) / **Education**

State

university

National
(MESC***)
Secondary and
tertiary
education/research/
policy inputs
65 18 28
The Farmers Association (FA)
Agricultural
Business
Interest
organization
National
Administration/policy
interest monitoring
50 64 65
The Icelandic Agricultural Advisory
Centre (IAAC). **Agricultural**
Sister company
of the FA
National Agricultural advisory 48 ↑ ↑
The Icelandic Institute of Natural
History (IINH). **Environment**
Governmental
institute
National
(MENR)
Monitoring/research/
policy inputs
20 76 70
National parks (NP)**
Environment
Governmental
agencies
National
(MENR)
Control/information/
policy inputs
17 ↑ ↑
The Icelandic Forest Service (IFS)
Environment
Governmental
institute
National
(MENR)
Practice/control/advis
ory/
research/policy
inputs
45

↑ ↑

The Soil Conservation Service of
Iceland (SCSI). **Environment**

Governmental

institute

National

(MENR)

Practice/control/

advisory/

research/policy

inputs

26

↑ ↑

1 Overall 503 234 47

2 ↑Symbolizes that all the replies from respondents within the agricultural sector were merged to one number; so were all the replies

3 from respondents within the environmental sector

4 *Local authorities of all regions officially defined as economically depending on sheep farming

5 **All permanent staff of the Vatnajökull, Thingvellir and Snæfellsnes national parks

6 ***Acronym for the Ministry of Education, Science and Culture

78

Rangeland management

9 All sectors (Table 3) strongly supported the position that sheep grazing should be practiced on

10 highland commons that according to scientific research results have sufficient carrying capacity

11 (Table 4). Nevertheless, significantly fewer ($P<0.05$) respondents from the sectors of
12 agriculture, local authorities and sheep farmers, compared to than those from the
education and

13 environment sectors, felt that decisions on what land is suitable for grazing should depend on

14 expert advice or supported the statement that highland commons should preferably not be grazed

15 (Table 4).

16 The educational and environmental sectors were significantly more ($P<0.05$) in favor of limiting

17 the grazing period in the highland commons from mid-June to end of August and were also more

Commented [31]: I don't think there is need to cite the table more than once in the paragraph, unless you are citing multiple tables and there is a question which one applies.

15

1 supportive ($P<0,05$) of the practice of sheep grazing on collective lowland areas, compared to

2 the agricultural sector, local authorities and the sheep farmers (Table 4). Furthermore, the

3 educational and environmental sectors and the officials were significantly less ($P<0.05$)

4 supportive of the current rangeland grazing management system, and of grazing rangelands until

5 it starts to snow in the autumn, or of grazing rangelands in winter, than were the

6 regional authorities? s and the sheep farmers.

78

Table 4. Mean rankings (1= strongly disagree – 5= strongly agree) of all agents (by sectors of profession; Table 2)

9 and the sheep farmers' attitude concerning how to manage sheep grazing on highland commons and other

10 rangelands. Education = agents working at the AUI (N = 18), Environment = agents working at the IINH, NPs, IFS

11 and SCSi (N = 76), Officials = parliamentarians and agents working at the MENR and MII (N = 19), Agriculture =

12 agents working at the FA and FAS (N = 64), Regionals = members of the local authorities within regions officially

13 defined to be depending on sheep farming (N = 57) and sheep farmers (N = 467). Mean ranks within rows identified

14 with the same superscript letter were not significantly different ($P > 0.05$).

Attitude towards rangeland management Education Environment Officials Agriculture Regionals Sheep farmers

1) Length of the grazing period at the highland commons:

a) Never before mid of June 3.9 a 3.8 a 3.4 ab 3.0 b 2.7 c 2.5 c

b) Never longer than till end of August 3.2 a 3.1 a 2.4 b 2.1 b 2.2 bc 1.9 c

2) Sheep grazing shall be practiced on:

a) currently grazed areas 2.2 a 2.4 a 2.7 ab 3.1 b 3.8 c 3.9 c

b) highland commons that, according to research have sufficient carrying capacity 4.1 a 4.1 a 4.2 a 4.2 a 4.3 b 4.1 a

c) collective fenced areas in the lowland 3.7 a 3.7 a 3.8 a 3.0 b 2.7 b 2.7 b

d) fenced, privately owned lowland 4.0 a 3.9 a 3.8 a 3.5 a 3.1 b 2.9 b

e) in areas depending on sheep farming 2.7 a 2.8 a 2.9 ab 2.7 a 3.3 b 3.2 b

3) It's acceptable to graze rangeland in the lowland:

a) until it starts to snow in the autumn 2.4 a 2.7 ab 3.2 b 3.2 b 3.5 c 3.3 bc

b) never in winter 3.8 b 3.9 b 3.6 ab 3.3 a 3.0 a 3.2 a

4) Land considered suitable for sheep grazing:

a) grassland and well vegetated land 4.6 a 4.4 a 4.1 a 4.5 a 4.3 a 4.5 a

b) depends on experts' advices 4.1 a 4.0 a 4.0 a 3.5 b 3.4 bc 2.9 c

c) poorly vegetated land should not be grazed 3.9 ab 4.3 a 3.8 b 3.8 b 3.8 b 3.6 b

d) highland commons should preferably not be grazed 2.9 ab 3.1 a 2.7 ab 2.2 b 2.3 b 2.0 b

15

16 Collaboration

17 Over 75% of all respondents agreed with the statement that farmers work cooperatively on restoration projects, that they are not only forced by law and legislation to practice restoration

19 and that their work is implemented in good collaboration with the SCSi (Table 5). Over 60% of

20 all respondents see restoration as a societal responsibility that the state should

21 subsidize, although this was significantly less ($P < 0.05$) favored by the officials, compared to

22 the agricultural sector and the sheep farmers. The environmental and the educational sectors and

23 the officials were significantly more ($P < 0.05$) in favor of keeping restoration subsidies low low,

24 than were the other three sectors. were (Table 5).

Commented [32]: Unclear meaning:

Is it: that they are NOT forced by law..

Or

That they are forced by law ...

The phrase 'not only' is confusing

16

1 **Table 5.** Mean rankings of all employees (by sectors of profession; Table 2) and the sheep farmers' attitude

2 concerning collaboration and incentives in rangeland restoration (1= strongly disagree – 5= strongly agree).

3 Education = agents working at the AUI (N = 18), Environment = agents working at the IINH, NPs, IFS and SCSi (N

4 = 76), Officials = parliamentarians and officials working at the MENR and MII (N = 19), Agriculture = agents

5 working at the FA and FAS (N = 64), Local authorities = members of the local authorities within regions officially

6 defined to be depending on sheep farming (N = 57) and sheep farmers (N = 467). Mean ranks within rows identified

7 with the same superscript letter were not significantly different ($P > 0.05$).

Attitude towards collaboration Education Environment Officials Agriculture Local authorities

Sheep

farmers

1) Collaboration in rangeland restoration:

a) Farmers work cooperatively in restoration

projects 3.9 a 4.2 b 4.1 a 4.3 b 4.2 b 3.9 a

b) Law and legislations force farmers to practice

restoration 2.7 b 2.3 ab 2.4 ab 2.3 ab 2.4 ab 2.2 a

c) Good cooperation between farmers and SCSi 3.7 a 4.2 c 4.3 c 4.0 b 4.1 bc 4.0 b

d) The agri-environmental sectors are jointly

planning restoration projects 3.5 a 3.4 a 3.6 a 3.4 a 3.5 a 3.3 a

2) Direct incentives for increased restoration:

a) Restoration is a societal task the state should

subsidize 3.9 ab 4.1 ab 3.7 b 4.2 a 3.9 ab 4.1 ab

b) Restoration subsidies should be low 3.2 b 3.0 b 3.2 b 2.7 a 2.7 a 2.6 a

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Governance and policies

10 All sectors, with the exception of the except the officials (the parliamentarians

11 and ministry officials) strongly supported the argument that rangeland restoration should

be 12 managed at a regional level (Table 6). The environmental and the educational sectors

and the 13 officials were significantly less in favor of the statement that rangeland restoration

should be 14 under the control of the Farmers Association, compared to the other sectors

(Table 6). All

15 sectors strongly supported the argument that the study of rangeland restoration should be part of

16 the compulsory curriculum for all those studying agricultural science, although sheep
 17 farmers were significantly less ($P < 0.05$) in favor of this view, compared to the environmental
 18 sector.
 19 Close to 50% of all respondents supported the argument that state rangeland restoration
 20 policies lack focus and clarity of purpose. Additionally, around 40% of the respondents neither
 21 agreed nor disagreed with the statement (Table 6). Responses to the statements that the FA
 22 actively participates in designing rangeland restoration policies and that rangeland restoration
 23 policies are designed in collaboration with farmers/land users were ambivalent. All sectors strongly
 24 supported the statements that municipalities should actively participate in designing
 25 restoration policies, and that agricultural and environmental institutes should follow a joint policy for
 26 restoration and sheep grazing, although in both cases the sheep farmers were significantly
 27 less supportive than were the environmental sector. (Table 6).

28 **Table 6.** Mean rankings of all employees (by sectors of profession; Table 2) and the sheep
 29 farmers' attitude towards governance and policies concerning rangeland restoration and management (1= strongly
 30 disagree – 5= strongly agree). Education = agents working at the AUI (N = 18), Environment = agents working at
 31 the IINH, NPs, IFS and SCSi (N = 76), Officials = parliamentarians and officials within the MENR and MII (N =
 32 19), Agriculture = agents working at the FA and FAS (N = 64), Local authorities = members of the local authorities
 33 within regions officially defined to be depending on sheep farming (N = 57) and sheep farmers (N = 467). Mean
 34 ranks within rows identified with the same superscript letter were not significantly different ($P > 0.05$).

17 **Attitude towards governance and policies**

Education Environment Officials Agriculture

Local authorities

Sheep farmers

1) Rangeland restoration:

a) Should be managed at a regional level 4.1 ab 4.4 a 3.2 c 4.2 a 4.1 ab 3.9 b

b) Should be under the custody of the SCSi* 3.2 a 3.5 a 3.5 a 3.6 a 3.3 a 3.5 a

c) Should be under the custody of the FA* 2.6 a 2.7 a 2.5 a 3.1 b 3.3 b 3.3 b

d) Should be part of the compulsory curriculum for

all studying agricultural science 4.3 a 4.5 a 4.1 ab 4.1 ab 3.9 bc 3.7 c

2) Rangeland restoration policies:

a) Governmental policies are focused and clear 2.5 a 2.3 a 2.7 a 2.5 a 2.6 a 2.5 a

b) The FA actively participate in designing

governmental rangeland restoration policies 3.1 ab 2.6 a 3.1 ab 2.8 a 3.2 b 3.1 ab

c) The government design rangeland restoration

policies in collaboration with farmers/land users 3.3 a 3.1 a 3.8 b 3.3 a 3.3 a 3.2 a

d) The ministries for agriculture and environment
should jointly form governmental restoration
policies

4.2 bc 4.4 c 4.2 bc 3.9 b 3.9 b 3.6 a

e) Municipalities should actively participate in
designing governmental restoration policies 4.2 bc 4.3 c 4.2 bc 4.1 b 3.9 ab 3.8 a

f) Agricultural and environmental institutes should
follow a joint policy for restoration and sheep
grazing

4.1 bc 4.3 c 4.2 bc 3.8 b 4.0 b 3.5 a

12

18

1 Discussion

2 This research mapped the political-administrative structure of the governance system for
3 rangeland management in Iceland. It and assessed through a national survey if the
governance

4 process within the system was likely to enhance sustainable improved rangeland
management

5 practices among sheep farmers, in line with current agri-environmental policy. Based on the
6 results, we also estimated how well the governance structure is perceived to
7 operate vertically and horizontally. The findings introduced in this paper are based on
replies

8 from 38% of all Icelandic sheep farmers (480 replies) that were member of the Sheep
farming

9 association at the time the research was conducted and 47% of all public/partially public
10 employees (234 replies) identified to have as having a direct or indirect administrative role
11 within the governance system of rangeland management..

12 The survey revealed substantial difference in what the different sectors considered to be
good

13 rangeland management practices (Table 4). The public administrators, (officials), the
environmental and the educational sectors have, for instance,

15 recognized the importance of sustainable rangeland management strategies to a greater
extent

16 more than does the agricultural sector and local authorities. The latter two sectors, along
with the

17 sheep farmers, favored the traditional rangeland utilization practices as described earlier in
this

18 paper, while the replies from the environmental and the educational sectors were more in
line

19 with contemporary understandings for of what practices should be considered as
sustainable

20 rangeland management in Iceland, as described in Petursdottir et al. (2017).

21 These results are in line with several other recent Icelandic research findings indicating
that also

22 indicating that the QMS scheme and above mentioned interventions might not be
23 facilitating long-term system transition towards sustainable rangeland management as
intended.

24 Petursdottir et al. (2013; 2017), for instance, found that for instance that even though
sheep

25 farmers shared positive attitudes among sheep farmers toward restoration and were even
their
26 actively participation in rangeland restoration projects, (governmental ones or on their
27 voluntary projects own), this did not influence their rangeland management practices in
28 practice. Furthermore, and that lack of cooperation between the agricultural and
environmental
29 sectors might be preventing the desired policy development. Furthermore, Berglund et al.
(2013)
30 stated that participatory practices were weak in rangeland restoration projects, with respect
to the
31 role of stakeholders in policy development. Similarly, Þorláksdóttir (2015) found that
farmers in
32 North East Iceland participating in the QMS for rangeland management felt that they are
not
33 given an active voice within the system, claiming that the scheme is too “top down”, that
there is
34 limited consensus between different actors in relation to priorities and methods, and that
the
35 objectives of sustainable land use and restoration are unclear. Finally, according to the
findings
36 of Stefánsson (2018) a selection of governmental employees working on within the
governance
37 system of rangeland management find the QMS to be lacking functionality, eventually not
38 achieving the target of halting unsustainable rangeland utilization.
39 All these findings can be linked to the limitations on how the characteristics concept of
40 sustainable land management/land use has been defined and disseminated by the
agricultural
41 sector within the governance system of the SES of rangeland management.
42 A thorough ecological understanding, derived from both scientific and traditional
ecological
43 knowledge, is claimed to be a fundamental pillar for sustaining an effective adaptive
governance
44 system of an SES (Folke, 2006; Bark et al., 2012). One of the initial aims of the QMS
scheme
45 was to build up ecological understanding and facilitate behavioral changes among sheep
farmers
19
1 towards more sustainable rangeland management by setting a legal framework to clarify
what
2 can be considered as sustainable rangeland use (Arnalds, 2019). Nevertheless, since 2003,
the
3 term sustainable land management (SLM) has officially been defined by the agricultural
sector
4 and appeared in agricultural regulations as a short, well-defined scientific term (Table x)),
rather
5 than instead of being regarded more as a framework, one that incorporates the various
6 dimensions of including the various aspects behind sustainability; such as productivity,
security,
7 protection, viability and acceptability (FAO skilgreiningin). This narrow approach has been

8 highly criticized by environmental scientists and the SCSI, pointing out that the current
SLM
9 definition leaves out fundamental ecological principles, such as the current ecosystem
condition
10 and thus, is incapable of clarifying what can be considered unsustainable land
management
11 (Arnalds, 2019).
12 Berglund et al. (2013) stated that participatory practices were weak in rangeland
restoration
13 projects, with respect to the role of stakeholders in policy development. Similarly,
Þorlákssdóttir
14 (2015) found that farmers in North East Iceland participating in the QMS for rangeland
15 management felt that they are not given an active voice within the system, claiming that
the
16 scheme is too “top down”, that there is limited consensus between different actors in
relation to
17 priorities and methods, and the objectives of sustainable land use and restoration are
unclear.
18 Finally, according to the findings of Stefánsson (2018) a selection of governmental
employees
19 working within the governance system of rangeland management find the QMS to be
lacking
20 functionality, eventually not achieving the target of halting unsustainable rangeland
utilization.
21 A thorough ecological understanding derived from both scientific and traditional
ecological
22 knowledge is claimed to be a fundamental pillar for sustaining an effective adaptive
governance
23 system of an SES (Folke, 2006; Bark et al., 2012). We detected different understanding of
what
24 sustainable rangeland management implies between the sheep farmers and the regional
and
25 agricultural sectors on one hand and the environmental and the educational sectors on the
other
26 hand (Table 4), indicating a knowledge gap between these sectors. It might be related to
the
27 previously detected weak emphasis of programs, such as QMS, FHL and LIF, on detailing
what
28 sustainability actually implies (Þorlákssdóttir, 2015; Berglund et al. 2013; Petursdottir et
al.,
29 2017).
30 Furthermore, the Agricultural University is the only educational institute in Iceland that
offers a
31 university degree in agricultural science and sustainable land management. Thus, its
academic
32 role in the transfer of scientific knowledge concerning sustainable rangeland management
and
33 restoration to all studying agricultural science is of high importance. Although the
majority of all

34 participants in our survey agreed that rangeland restoration should be part of the compulsory curriculum for students studying agricultural science (Table 6), this is not presently the case. Although rangeland management and restoration courses are taught at the AUI, the university's course catalogue shows they are optional for students pursuing agricultural science; potentially leaving a scientific gap in knowledge transfer, for instance to new agricultural experts and advisors, and in some cases also to new farmers. Dale et al. (2013) stated argue that institutions tend to build their own culture that, in many cases, creates functional silos and institutional fragmentation within the wider system. Different perceptions of sustainable rangeland management detected in replies from the environmental and educational sectors, on one side, and the agricultural, regionals and the farmers, on the other side (Table 4), strongly indicates the existence of institutional fragmentation (e.g. Zelli, 2015) between the sectors. Our results also strongly indicate that the administrative changes within the system, such as the establishment of the FHL project in 1990 and the QMSQLMS programme in 2003, as well as the transfer of auspice competencies over environmental and academic institutes agencies between ministries, have not enhanced understanding of the ecological knowledge capacity understanding of on what sustainable rangeland management implies involves among related stakeholder groups, in particularly within the agricultural sector (Table 4). Instead, they might have even deepened the previously detected functional silos between the ministries in charge of environmental and those charged with dealing with agricultural issues, as well as between related institutes and organizations (Stefánsson, 2018; Petursdottir et al., 2013). Furthermore, the QMS scheme was intended to have positive impact on the governance structure by, for instance setting the frame for improved rangeland management, based on a "Declaration of Intent" made by major stakeholder groups in the year 2000 (Arnalds, 2019). The first regulation on the QMS, initiated in 2003, drew upon the Declaration. The regulation was revised in 2008 and again in 2013 where considerable changes were made on the QMS scheme concerning the land use factor. According to a recent paper, all these regulations were too lenient, not taking into account the existing ecological knowledge on the rangeland systems (Arnalds, 2019). Furthermore, the SCSI—, that was responsible for verifying the criteria for acceptable land use within the QMS scheme— officially objected to the content of

19 the draft of the 2013 regulation. The agency, for instance, stated that the regulation needed
 to
 20 include more stringent rules regarding what could be considered as sustainable land use,
 but its
 21 concerns were not taken into consideration by the agricultural minister (Arnalds, 2019).
 The
 22 regulation was revised again in 2015 by the agricultural minister and, despite of strong
 23 objections by the SCSi, the conditions for sheep farmers to achieve subsidy payments for
 their
 24 production were extended at the cost of the conditionin trade-off with the conditions
 related to
 25 the status of the rangeland ecosystems (Arnalds, 2019).
 26
 27 Effective governance systems aimed at the promotion of sustainable improved rangeland
 28 management requires a well-defined organizational structures alongside an
 institutionalized
 29 system for inter- and intra- organizational collaboration and for public/private partnerships
 (e.g.
 30 Provan & Kenis, 2008). Our results indicate that, although more than 75% of all
 respondents
 31 positively value share the perception that while stakeholders work on rangeland
 restoration
 32 projects that work in close collaboration with the SCSi (Table 5), the knowledge
 application
 33 within the SES related to sustainable rangeland management and rangeland restoration, is
 34 fragmented, and not fully supporting the knowledge transfer needed, across sectors and
 35 institutions. Furthermore, knowledge on how to analyze the ecological condition status of
 36 rangelands in accordance with robust scientific methods seems to be mainly accumulating
 within
 37 the environmental and the educational sectors of the system (Table 4). Although the
 current
 38 rangeland management and restoration programs and projects, listed earlier in this paper,
 were
 39 designed to gradually increase cross-sectoral collaboration and horizontal and vertical
 40 knowledge transfer within the SES (e.g. Arnalds, 2005; Aradóttir & Halldórsson, 2012),
 they are
 41 not co-managed in ways that would support such cross-sectoral engagement. As such, and
 our
 42 results indicate that they have not significantly strengthened the governance process in
 support
 43 of policy and knowledge integration (Table 6).
 44 Increased institutional capacity concerning to deal with conflict resolution, as well as
 improving
 45 the stakeholders' ability to participate in knowledge generation and in the decision-making
 21
 1 process are seen as key instruments into facilitating the transformation towards
 2 adaptive governance (Brunner et al., 2005; Bark et al., 2012; Chaffin et al., 2014). Our
 results
 3 indicate that the decision-making capacity for rangeland management was low (Table 4 and
 6).

4 For instance, more than half of respondents claimed rangeland restoration policies were
5 unfocused and unclear in their intent. Furthermore, the content of current policies seemed
6 were
7 deemed to be improperly poorly disseminated, within the SES as with around 40% of all
8 participants in the survey were not sure how to reply to questions related to rangeland's
9 restoration policies and the majority of the respondents them were not sure who participates
10 in the policy making process (Table 6).
11 The officials (i.e. the parliamentarians and ministry officials) were shown to perceive
12 rangeland
13 management and restoration activities through a different lens than the other sectors.
14 Compared
15 to the other sectors, they were significantly more in favor of the view that rangeland
16 administration should be undertaken at the national rather than regional level, and of the
17 view
18 that the government design rangeland restoration policies in collaboration with farmers
19 and other
20 land users. Nevertheless, there was strong support for increased cross-sectoral
21 collaboration
22 between ministries and other administrative sections for the design and implementation of
23 rangeland management policies and for including studies on rangeland management and
24 restoration in the compulsory curriculum for all pupils studying agricultural science (Table
25 6).
26 The findings of Petursdottir et al. (2013) based on interviews of five key stakeholders and
27 ten
28 sheep farmers, indicated that the Icelandic SES of rangeland management focusing on
29 restoration was not fully operational, most likely due to lack of institutional strength
30 capacity
31 and internal coherence. Petursdottir et al. (2013) also stated found that key that
32 necessary institutional key institutional norms, arrangement, such as cooperation and
33 transparency within the Icelandic SES of rangeland management, were limited weak, with
34 and
35 the existence of functional silos within the system was reducing the vertical and horizontal
36 knowledge transfer within the governance process. The findings introduced in this paper
37 are
38 based on replies from 38% of all Icelandic sheep farmers (480 replies) that were member
39 of the
40 Sheep farming association at the time the research was conducted and 47% of all
41 public/partially
42 public employees (234 replies) identified to have a direct or indirect administrative role
43 within
44 the governance system of rangeland management. The findings of this current research
45 detected
46 fragmented institutional arrangements, functional silos and limited cross-sectoral
47 knowledge
48 management transfer within the rangeland management system, revealed in this research,
49 which
50 support are supporting the findings of Petursdottir et al. (2013). They also further
51 emphasize,
52 emphasizeing further the need for a comprehensive governance transformation, toward for

35 instance adaptive governance, to achieve sustainable rangeland utilization within the SES
of
36 rangeland management and –restoration in Iceland.

37

38 **Conclusion**

39 Our results strongly indicate that the current administrative structure hasn't significantly
has not

40 facilitated either the expected attitude changes within the agricultural sector or among
local

41 authorities nor behavioral changes among sheep farmers towards improved sustainable
rangeland

42 management, in line with current agricultural and environmental policy targets.

Furthermore,

43 they support previous findings that the governance system for rangeland management in
Iceland

44 is structurally limited and partially dysfunctional. This negatively affects the potential of
the

45 administrative potential of the system to implement and sustain the practices of
sustainable

22

1 rangeland management among sheep farmers and other land users. The loose complex and
2 highly fragmented structure of the agricultural administration, as the map of political and
3 administrative structure of the governance system shows, the exclusion of the MENR and
its

4 agencies from the policy process, and the lack of direct access of the farmers'

5 business interest organizations (FA) to the policy and decision -making process within the
MII

6 concerning rangeland management need in particular to be addressed. considered carefully
in this 7 context addressed. In addition, attention needs to be paid to the detected knowledge
gaps related 8 to ecological knowledge transfer and use for and sustainable improved land
management 9 practices. between the various public/partially public employee groups that
answered our survey. 10 Furthermore, we point to the limitations arising from the lack of ano
formal platform for 11 participatory forms of rangeland governance exists, leaving few
opportunities for more active 12 participation and information sharing between and within the
stakeholder groups, and between 13 them and the administrative districts and other
institutions operating within the system of

14 rangeland governance.

15 Our results strongly indicate that, although the administration of rangeland structure
within

16 the SES of rangeland management has changed gradually improved in the last 30 years,
the

17 system's institutional settings and governance practices have not adopted adaptive
governance

18 approaches (AG), despite their obvious advantages advantages their processes.

19 Our findings clearly reveal the need for improved governance for rangeland management
and

20 the need for increased level of knowledge application within the system. Furthermore, no

21 formal platform for participatory forms of rangeland governance exists, leaving few

22 opportunities for more active participation and information sharing between and within the

23 stakeholder groups, and between them and the administrative districts and other
institutions
24 operating within the system of rangeland governance
25 To secure sustainable sheep grazing on rangelands, the related SES should be governed in
an
26 adaptive way (AG) and managed toward improving and maintaining ecosystem services
and
27 functions prior traditions and socio-economic interests. We thus conclude that the entire
28 governance structure surrounding the system needs to be reformed to overcome
institutional
29 barriers within partly dysfunctional SESs, such as the one investigated in this research. We
30 propose a three step transformation phase in such a reform, where the first step should be
the
31 establishment of a professional trans-disciplinary platform for decision making in the field
of
32 rangeland management. The platform should be responsible for creating a comprehensive
agri-
33 environmental policy based on an ecosystem approach and approved and accepted by
majority
34 of all public sectors and other involved stakeholder groups. The second step should be to
35 actively increase cross-sectoral knowledge transfer within the system, including through
local
36 involvement in all its decision-making processes. The third step should be to encourage
system
37 transform towards adaptive governance and in parallel apply co-adaptive management
38 approaches with build-in regular evaluation of both the governance process and its
outcomes.

39

40 **Acknowledgements**

41 This work was supported by the Energy Research Fund of Landsvirkjun and the
Agricultural
42 Productivity Fund in Iceland.

43

23

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